Marine Mammal Monitoring During a Low-Energy Seismic and Coring Survey in the South Pacific Ocean by the Scripps Institution of Oceanography Research Vessel ROGER REVELLE.

December 2006-January 2007

Prepared by

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FORWARD

This document serves to meet reporting requirements specified by the National Marine Fisheries Service, Office of Protected Resources (NMFS/OPR) in and Incidental Harassment Authorization (IHA) issued to Scripps Institution of Oceanography (SIO) on December 12, 2006. The IHA (Appendix A) authorized non-lethal takes of certain marine mammals incidental to a marine seismic survey in the South Pacific Ocean. Behavioral disturbance of marine mammals is considered to be "take by harassment" under the provisions of the U.S. Marine Mammal Protection Act (MMPA).

The temporary or permanent impact of seismic exploration sounds to any marine mammals is unknown. Nonetheless, to minimize the possibility of any injurious effects (auditory or otherwise), and to document the extent and nature of any disturbance effects, NMFS requires that seismic research conducted under IHAs include provisions to monitor for marine mammals and to power down the seismic sources when mammals are detected with in designated safety radii. Safety radii were defined based on the estimated radius at which the received level of seismic sounds (on an rms basis) was expected to diminish to 180 db re 1uPa, as specified by NMFS. The IHA also required monitoring and mitigation procedures to minimize potential harassment of sea turtles using the same safety zone.

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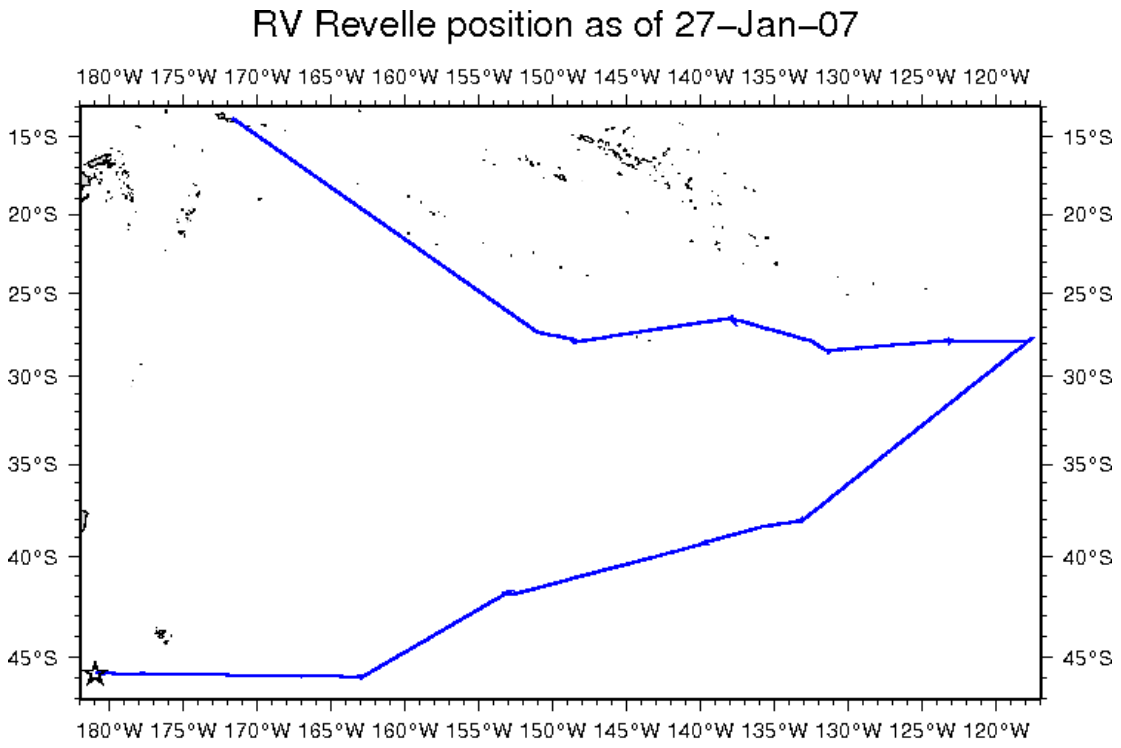
I. INTRODUCTION

A site survey cruise for the International Ocean Drilling Program (IODP) was conducted by the Scripps Institution of Oceanography aboard the Research Vessel Roger Revelle in the Eastern Tropical Pacific Ocean (Figure 1). The low-energy seismic reflection system was just one tool in the integrated marine geology and geophysical studies that also employed a bathymetric echosounder, passive geophysical sensors (gravimeter, magnetometer), and geologic sampling tools (piston core, benthic core, multi-core, benthic lander).

The purpose of the research program was to conduct a piston/gravity coring, magnetic, and seismic survey program at 12 sites in the South Pacific Ocean. The results will be used to (1) document the metabolic activities, genetic composition, and biomass of prokaryotic communities in the subseafloor sediments with very low total activity; (2) quantify the extent to which those communities may be supplied with harvestable energy by water radiolysis, a process independent of the surface photosynthetic world; and (3) survey broad characteristics of subseafloor communities and habitats in this region, in order to refine the planning and objectives of IODP drilling proposal 662-full (Life beneath the Seafloor of the South Pacific). The seismic survey was required to locate optimal piston/gravity-coring sites.

The cruise departed Apia, Western Samoa on December 17, 2006 and ended in Dunedin, New Zealand on January 27, 2007. The research was completely in International Waters as well as the New Zealand Exclusive Economic Zone (EEZ). There were a few days transiting with the ship to and from port; no scientific work was performed while within the claimed EEZ limits of several nations.

Figure 1. Cruise track of *R/V Roger Revelle*



II. SCIENTIFIC PERSONNEL

Two observers were onboard for the entire cruise specifically to conduct the marine mammal mitigation and monitoring procedures. All observers were accredited by NMFS, having previous training and experience with NMFS marine mammal surveys in the Pacific Ocean. In addition, all observers had experience in field identification of sea turtles.

The full scientific party list was:

NAME	POSITION	INSTITUTION
D'HONT, S.	CHIEF SCIENTIST	GSO/URI
ABRAMS, L.	SCIENTIST	UNCW
ANDERSON, R.	STUDENT	GSO/URI.
DORRANCE, J.	MARINE TECHNICIAN	SIO
DURBIN, A.	GRADUATE STUDENT	UNC
ELLET, L.	GEOPHYSICAL ENGINEER	SIO
FERDELMAN, T.	SCIENTIST	MPI-BREMEN
FISCHER, J.	SCIENTIST	MPI-BREMEN
FULDAUER, R.	STUDENT	GSO/URI
GOLDSTEIN, H.	MARINE MAMMAL OBSERVER	SIO
GRAHAM, D.	SCIENTIST	GSO/URI
GRIFFITH, B.	TEACHER AT SEA	URI/ARMADA
HALM, H.	GRADUATE STUDENT	MPI-BREMEN
HARRIS, R.	SCIENTIST	OREGON ST. U.
HARRISON, B.	GRADUATE STUDENT	CALTECH
HASIUK, F.	GRADUATE STUDENT	U. OF MICHIGAN
KALLMEYER, J.	SCIENTIST	GFZ POTSDAM
LEVER, M.	GRADUATE STUDENT	UNC
MEYER, J.	COMPUTER TECHNICIAN	SIO
MORSE, L.	MARINE MAMMAL OBSERVER	SIO
MOSER, C.	CORING TECHNICIAN	OREGON ST. U.
MURPHY, B.	GEOPHYSICAL ENGINEER	SIO
NORDHAUSEN, A.	SCIENTIST	MPI-BREMEN
PARRY, L.	MARINE TECHNICIAN	SIO
POCKALNY, R.	SCIENTIST	GSO/URI
ROGERS, J.	GRADUATE STUDENT	GSO/URI
SCHRUM, H.	GRADUATE STUDENT	GSO/URI
SMITH, D.	SCIENTIST	GSO/URI
SOFFIENTINO, B.	SCIENTIST	GSO/URI
SPIVACK, A.	SCIENTIST	GSO/URI
STANCIN, A.	GRADUATE STUDENT	U. OF MICHIGAN
STEINMAN, M.	STUDENT	GSO/URI
WALCZAK, P.	CORING TECHNICIAN	OREGON ST. U.

III. SEISMIC SYSTEMS

The generator chamber of each GI gun, the one responsible for introducing the sound pulse into the ocean, is 45 in^3. The larger (105 in^3) injector chamber injects air into the previously-generated bubble to maintain its shape, and does not introduce more sound into the water. The two 45 in^3 GI guns will be towed 8 m apart side by side, 21 m behind the *Roger Revelle*, at a depth of 2 m. The sound pressure field of that GI gun variation has not been modeled, but that for two 45 in^3 Nucleus G guns has been modeled by L-DEO in relation to distance and direction from the airguns (see below).

As the airguns are towed along the survey line, the towed hydrophone array in a 800-m streamer receives the reflected signals and transfers the data to the on-board processing system. Given the relatively short streamer length behind the vessel, the turning rate of the vessel while the gear is deployed is much higher than the limit of five degrees per minute for a seismic vessel towing a streamer of more typical length (>>l km). Thus, the maneuverability of the vessel is not limited much during operations.

GI Airgun Specifications

Energy Source	Two GI guns of 45 in^3
Source output (downward)	0-pk is 3.4 bar-m (230.6 dB re 1 µPa·m); pk-pk is 6.2 bar-m (235.8 dB)
Towing depth of energy source	2 m
Air discharge volume	Approx. 90 in^3
Dominant frequency components	0–188 Hz
Gun positions used	Two side by side guns 8 m apart
Gun volumes at each position (in^3)	45, 45

The nominal downward-directed source levels indicated above do not represent actual sound levels that can be measured at any location in the water. Rather, they represent the level that would be found 1 m from a hypothetical point source emitting the same total amount of sound as is emitted by the combined GI guns. The actual received level at any location in the water near the GI guns will not exceed the source level of the strongest individual source. In this case, that will be about 224.6 dB re 1µPa-m peak, or 229.8 dB re 1µPa-m peak-to-peak. Actual levels experienced by any organism more than 1 m from either GI gun will be significantly lower.

A further consideration is that the rms[1] (root mean square) received levels that are used as impact criteria for marine mammals are not directly comparable to the peak or peak to peak values normally used to characterize source levels of airgun arrays. The measurement units used to describe airgun sources, peak or peak-to-peak decibels, are always higher than the "root mean square" (rms) decibels referred to in biological literature. A measured received level of 160 decibels rms in the far field would typically correspond to a peak measurement of about 170 to 172 dB, and to a peak-to-peak measurement of about 176 to 178 decibels, *as measured for the same pulse received at the same location* (Greene 1997; McCauley et al. 1998, 2000). The precise difference between

[1] The rms (root mean square) pressure is an average over the pulse duration.

rms and peak or peak-to-peak values depends on the frequency content and duration of the pulse, among other factors. However, the rms level is always lower than the peak or peak-to-peak level for an airgun-type source.

Received sound levels have been modeled by Lamont-Doherty Earth Observatory of Columbia University (L-DEO) for a number of airgun configurations, including two 45-in^3 Nucleus G-guns, in relation to distance and direction from the airguns (Fig. 2). The model does not allow for bottom interactions, and is most directly applicable to deep water. Based on the modeling, estimates of the maximum distances from the GI guns where sound levels of 190, 180, 170, and 160 dB re 1 µPa (rms) are predicted to be received in deep (>1000-m) water are shown in Table 1. Because the model results are for G guns, which have more energy than GI guns of the same size, those distances are overestimates of the distances for the 45-in^3 GI guns.

Empirical data concerning the 180-, 170-, and 160- dB distances have been acquired based on measurements during the acoustic verification study conducted by L-DEO in the northern Gulf of Mexico from 27 May to 3 June 2003 (Tolstoy et al. 2004). Although the results are limited, the data showed that radii around the airguns where the received level would be 180 dB re 1 µPa (rms), the safety criterion applicable to cetaceans (NMFS 2000), varies with water depth. Similar depth-related variation is likely in the 190-dB distances applicable to pinnipeds. Correction factors were developed for water depths 100–1000 m and <100 m. The survey occured in depths 3200–5700 m, so the correction factors are not relevant here.

The empirical data indicate that, for *deep water* (>1000 m), the L-DEO model tends to overestimate the received sound levels at a given distance (Tolstoy et al. 2004). However, to be precautionary pending acquisition of additional empirical data, it is proposed that safety radii during airgun operations in deep water will be the values predicted by L-DEO's model (Table 1). Therefore, the assumed 180- and 190-dB radii are 40 m and 10 m, respectively.

TABLE 1. Distances to which sound levels ≥190, 180, 170, and 160 dB re 1 µPa (rms) might be received from two 45-in^3 G guns, similar to the two 45-in^3 GI guns that will be used during the seismic survey in the South Pacific Ocean during December 2006–January 2007. Distances are based on model results provided by the Lamont-Doherty Earth Observatory of Columbia University.

Water depth	Estimated Distances at Received Levels (m)			
	190 dB	180 dB	170 dB	160 dB
>1000 m	10	40	125	400

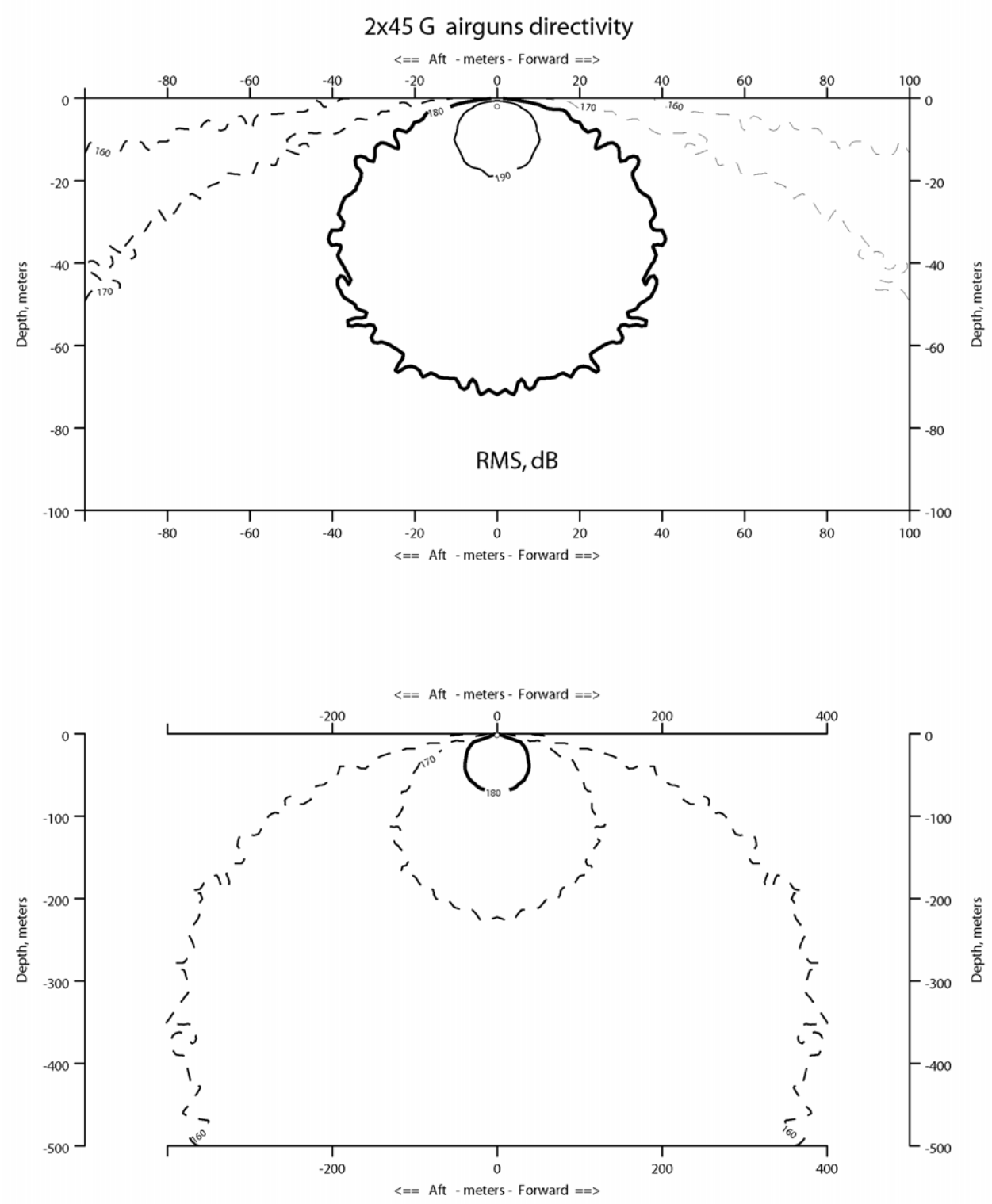


FIGURE 2. Modeled received sound levels from two 45-in^3 G guns, similar to the two 45-in^3 GI guns that will be used during the SIO survey in the South Pacific Ocean during December 2006–January 2007. Model results provided by the Lamont-Doherty Earth Observatory of Columbia University.

IV. MITIGATION PROCEDURES

The primary responsibility of the marine mammal observers (MMOs) was to maintain a watch for marine mammals, sea turtles, and other protected marine animal species with the designated 40-meter (for cetaceans and sea turtles) and 10-meter (for pinnipeds) safety radius around the seismic GI gun source, and alert the seismic personnel, who would then shut down the seismic source.

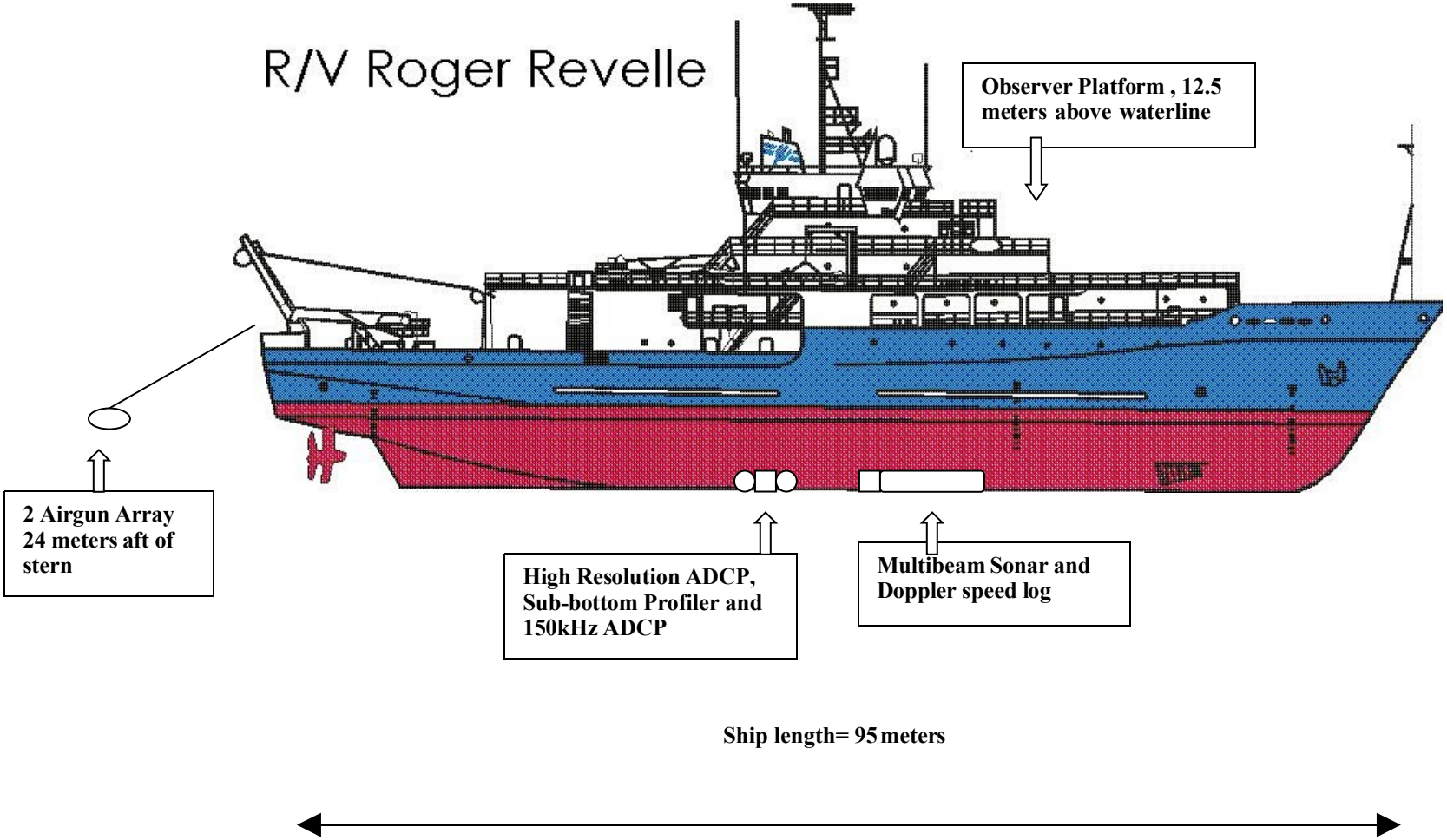
Mitigation watches by at least one observer were conducted 100% of the time during daylight hours (civil twilight-sunrise to civil twilight-sunset) of seismic operations, regardless of weather or sea conditions. On days in which no seismic operations were conducted, observers were on watch from sunrise to sunset. The daytime observer platform was located one deck below and forward of the bridge (12.46 meters above the waterline), affording relatively unobstructed 180-degree forward view. Aft views of the vessel could be obtained along the port and starboard decks (Figure 3).

During daylight startups before commencing seismic operations, one and/or two observers would maintain a 360-degree watch for all marine mammals and sea turtles for at least 30 minutes prior to ramp-up. During night start ups, watch was restricted to the 40 meter safety radius due to the limitations of night viewing. Nighttime observations, were conducted from the second level below the bridge looking aft for an unobstructed view of the air guns. Night vision binoculars were utilized for these periods. If no marine mammals or turtles were observed with the safety radius during this time, the observers would notify the seismic personnel of an "all clear" status. A ramp-up procedure was employed when beginning seismic operations. With the marine mammal observers on watch, one seismic source would be energized for 5 minutes. The second source would be brought on-line only after confirmation that no animals were sighted with the 180 dB safety radius. Once the airguns were ramped up during nighttime operations, no further marine mammal observations were required.

Watch periods were scheduled as a 2-hour rotation. The observers continually scanned the water from the horizon of the ship's hull, and forward of 90 degrees from the bow port and starboard. In the event of any marine mammal or sea turtle approaching or within the 40-meter zone, the seismic personnel were to be contacted via handheld radios and the seismic source was secured for the duration of the animal's presence with the zone, as determined by the observer on duty. Seismic operations would resume only after the animals were seen to exit the safety radius, or after no further visual detection of the animal for 15 minutes (for small ondontocetes and pinnipeds) or 30 minutes (for mysticetes and large odontocetes).

Observers utilized reticulated 25x150 big eye binoculars and 7x50 handheld binoculars to determine bearing and distance of sightings. A handheld fixed range finder and distance marks on the ship's gunnels were used to measure the exact location of the 40-meter zone (Heinemann 1981). These simple devices proved more reliable for open water sighting than the laser range finders, which were also provided.

Figure 3. Ship Specifics for Marine Mammal Observations



The marine mammal observers provided brief training to the bridge crew at the beginning of the cruise. More importantly, the bridge officers were instructed to alert the observer on watch of any suspected marine mammal sighting. A handheld radio was used by the observers for communication between them and the bridge. A phone and handheld radio were used to communicate with the seismic personnel and lab spaces. If needed, the bridge could be contacted in order to maneuver the ship to avoid interception with approaching marine mammals or sea turtles.

On occasion, seismic operations continued through the night, marine mammal observers would resume observations at civil twilight-sunrise. If seismic operations were halted at night, a 30 minute watch and ramp-up procedure were required before resuming operations. In addition, all nighttime seismic gear deployment and recovery were observed.

Data collection procedures were adapted from the line-transect protocols developed by the National Oceanic and Atmospheric Administration (NOAA) Southwest Fisheries Science Center (SWFSC) for their marine mammal abundance research cruises (Kinzey et al 2000; Mesnick, unpublished). The data collection sofwar package WinCruz (http://swfsc.nmfs.noaa.gov/PRD/software/WinCruz.pdf) written by Robert Holland at SWFSC was utilized for these cruises. A laptop computer was located on the observer platform for ease of data entry. The computer was connected to the ship's Global Position System (GPS), which allowed a record of time and position to be made at 3-minute intervals and for each event entered (such as sightings, weather updates and effort changes). WinCruz DAS files were created for each day's survey effort, and were edited and saved at the end of each day.

Watch effort is recorded in WinCruz in "passing" or "closing" mode. Passing mode indicated that the vessel does not purposely approach the sighting and so was used to exclusively for thes cruises. Effort is further identified as being "on" or "off". For the purpose of these cruises, "on effort" is when one or both observers are on watch.

When a marine mammal or sea turtle is first sighted, a sighting event is made in WinCruz, the bearing and distances are recorded and a unique number is generated for the specific sighting (Kinsey et. al. 2000). WinCruz automatically calculates distances when either 7x50, or 25x150 reticle values are entered based on the observers' height above the water (12.46 meters) (Table 2). Aided by the GPS input, WinCruz plots sightings on a real time map. This function allows observers to track animals and helps minimize duplicate sightings. The map is particularly useful in assisting with relocation of animals that are lost from view or to avoid duplicate sighting data of the same school or pod when the vessel changes course. At the completion of the sighting, estimates of group size were recorded. A two sided sighting form (NOAA form 88-208, Appendix B) was filled out detailing identification characteristics and behavior of the animals observed. Particular attention has been taken for this survey to record as much behavioral information as possible (Mesnick, unpublished).

Table 2. Calculated Distances in Reference to Reticle Values of Binoculars.

Reticle	Nmiles 7x	Meters	NM 25x	Meters	7x on bridge	Meters
0	6.81	12,598	6.81	12,598	7.46	13816
0.1	3.39	6278	4.71	8723	3.83	7093
0.2	2.59	4791	4.06	7519	2.96	5482
0.4	1.82	3367	3.3	6112	2.1	3889
0.6	1.41	2609	2.83	5151	1.64	3037
0.8	1.16	2146	2.49	4611	1.36	2519
1	0.99	1832	2.24	4148	1.16	2148
1.5	0.72	1332	1.8	3334	0.85	1574
2	0.57	1054	1.51	2797	0.67	1241
2.5	0.47	870	1.3	2408	0.56	1037
3	0.4	741	1.15	2130	0.47	870
4	0.31	574	0.93	1722	0.37	685
5	0.25	462	0.78	1444	0.3	556
6	0.21	388	0.67	1241	0.25	463
7	0.18	333	0.59	1093	0.22	407
8	0.16	296	0.53	981	0.19	352
9	0.14	259	0.48	889	0.17	315
10	0.13	240	0.44	815	0.16	296
11	0.12	222	0.4	741	0.14	259
12	0.11	203	0.37	685	0.13	240
13	0.1	185	0.34	630	0.12	222
14	0.09	166	0.32	593	0.11	203
15	0.09	166	0.3	556	0.11	203
16	0.08	148	0.29	537	0.1	185

Note: This scale is for the observer platform level on the RV-Roger Revelle (one level below bridge-12.47 meters), and the platform level on the bridge (14.97meters) this includes an average height for observers of 5ft 6 in.

The observers entered values in WinCruz for weather conditions, such as Beaufort state, swell, and visibility (quantified in nautical miles) as conditions changed during their watch. The SWFSC software also provides an event key to record vessel traffic, distance and bearing relative to the research ship. Finally, a comment key is available to add any additional information as necessary.

At the end of each day the observers checked the sighting data for errors and edited as appropriate. Behavioral data was coded and entered into separate databases for marine mammals and sea turtles (Mesnick, 2002).

In instances, events, and weather conditions where the MMO laptop computer could not be used, paper sheets were used to collect data and adapted from Lamont-Doherty Earth Observatory/LGL Environmental Consulting, Inc. marine mammal and sea turtle monitoring and observation procedures. The information collected by this method included observation location, date, watch start or end, observer on watch, time, vessel position (latitude and longitude), seismic activity, sea state, visibility, glare, and marine mammal sighting data (identification #, number of individuals, movement, behaviors, location, initial distance, closes point of approach, sighting cue, identification reliability, pace, and any other comments). The paper data sheets were checked for accuracy and the data entered into a computer database program.

When seismic operations were not being performed, watch was suspended during poor sighting conditions, such as high Beaufort sea state and rain. Watch was also suspended during coring operations during which time the vessel was on station and therefore not moving.

V. OBSERVATIONS/RESULTS

Seismic operations were conducted on 11 distinct periods during the 39 days of this cruise. (Table 3). The seismic source was active for a total of 68.28 hours of which 43.17 were during daylight hours with 100% observer coverage. Observers were on watch for an additional 298.57 hours during non-seismic periods when the ship was underway.

There were 23 sightings of marine mammals (Table 4) during this cruise. Off the 23 sightings, all were made during non-seismic periods.

There were no sea turtles observed during this cruise.

Table 3. Seismic Operations Log

Date GMT	Start GMT	End GMT	Tot time (Hr:min)	Total time:hrs	Start Lat	Start Long	End Lat	End Long	#guns	comments
12/20/2006	17:30				23.894 S	165.835 W			1	port gun
12/20/2006	17:38				23.894 S	165.822 W			2	both guns
12/21/2006		0:36	7:06	7.1			23.891 S	165.668 W		guns shut down
12/24/2006	0:10	5:53	5:43	5.7	25.974 S	157.090 W	26.096 S	156.977 W	1	only one gun
12/26/2006	17:13	0:16	7:03	7.05	27.766 S	148.79 W	27.751 S	148.683 W	1	only one gun
12/29/2006	23:48	5:23	5:35	5.6	26.516 S	138.116 W	26.565 S	137.912 W	1	only 1 gun,stbd
1/1/2007	8:15	14:58	6:43	6.72	28.376 S	131.656 W	28.369 S	131.398 W	1	only 1 gun, stbd
1/4/2007	1:12	9:02	7:50	7.83	27.844 S	123.142 W	27.840 S	123.162 W	1	only 1 gun, stbd
1/6/2007	8:50	13:33	4:43	4.72	27.834 S	117.71 W	27.841 S	117.621 W	1	only 1 gun, stbd
1/10/2007	21:40	4:41	7:01	7	37.985 S	132.972 W	38.134 S	133.038 W	1	only 1 gun, stbd
1/13/2007	9:50	16:22	6:32	6.53	39.222 S	139.526 W	39.300 S	139.840 W	1	only 1 gun, Stbd
1/17/2007	2:28	7:00	4:32	4.53	41.952 S	152.966 W	41.816 S	153.017 W	1	only 1 gun, Stbd
1/20/2007	5:54	11:24	5:30	5.5	46.024 S	163.064 W	45.911 S	163.083 W	1	only 1 gun, stbd

TABLE 4. Marine Mammal Sightings

Date	Time (GMT)	GMT offset	Sighting	LAT deg	LAT min	N/S	LON deg	LON min	E/W	Species Code	# of Animals	Air Gunning	Air Guns Stopped	Closest Dist. (meters)
1/1/2007	0:16	-10	1	27	45.45	S	133	2.99	W	177	15	No	No	400
1/2/2007	18:08	-10	2	28	20.62	S	129	58.99	W	177	40	No	No	1444
1/3/2007	14:15	-10	3	28	0.97	S	125	30.06	W	49	1	No	No	3823
1/3/2007	20:59	-10	4	27	54.28	S	123	58.6	W	61	4	No	No	4881
1/3/2007	21:33	-10	5	27	53.72	S	123	51.08	W	49	2	No	No	6112
1/7/2007	20:39	-10	6	28	54.78	S	119	17.53	W	49	9	No	No	6816
1/9/2007	23:57	-10	7	35	24.71	S	128	56.66	W	76	2	No	No	1241
1/9/2007	23:57	-10	8	35	24.72	S	128	56.66	W	177	40	No	No	6112
1/10/2007	18:00	-10	9	37	37.09	S	132	23.39	W	70	2	No	No	200
1/20/2007	20:25	-10	10	45	57.85	S	163	11.05	W	35	26	No	No	20
1/22/2007	17:00	-11	11	45	54.32	S	169	38.47	W	79	3	No	No	500
1/24/2007	21:48	-11	12	45	50.59	S	176	30.24	W	UA	1	No	No	300
1/24/2007	22:22	-11	13	45	50.52	S	176	37.66	W	UA	1	No	No	300
1/24/2007	22:28	-11	14	45	50.5	S	176	39.08	W	UA	3	No	No	980
1/24/2007	22:58	-11	15	45	50.45	S	176	45.56	W	UA	1	No	No	2400
1/24/2007	23:11	-11	16	45	50.42	S	176	48.51	W	35	18	No	No	1722
1/25/2007	0:07	-11	17	45	50.3	S	177	0.73	W	UA	1	No	No	1722
1/25/2007	0:10	-11	18	45	50.3	S	177	1.3	W	UA	1	No	No	380
1/25/2007	1:05	-11	19	45	50.19	S	177	13.24	W	79	1	No	No	5500
1/26/2007	7:18	-11	20	45	47.02	S	176	42.9	E	UA	1	No	No	50
1/26/2007	17:34	-11	21	45	45.81	S	174	45.97	E	UA	1	No	No	100
1/27/2007	2:13	-11	22	45	45.15	S	173	17.78	E	70	2	No	No	6112
1/27/2007	2:56	-11	23	45	44.95	S	173	10.29	E	79	1	No	No	2797

Species Key:
035= Globicephala melas (Long-Finned Pilot Whale)
049= Unidentified Ziphiid Whale (Beaked Whale)
061= Ziphius cavirostris (Cuvier's Beaked Whale)
070= Unidentified Balaenoptera, (Baleen Whale)
076= Megaptera novaengliae (Humpback whale)
079= Unidentified Large Whale
177= Unidentified Small Delphinid (Dolphin)
UA= Unidentifed Fur Seal

MITIGATION EFFECTIVENESS

Due to the absence of marine mammals, sea turtles and other protected marine species in the safety radius, no shut downs or other mitigation procedures were implemented during the entirety of the seismic operations for the oceanographic cruise.

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VI. APPENDICES

A. Incidental Harassment Authorization

B. NOAA Sighting Form

A. Incidental Harassment Authorization

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

DEC 12 2006

Mr. Woody C. Sutherland
Shipboard Technical Support
University of California, San Diego
Scripps Institution of Oceanography
La Jolla, California 92093-0214

Dear Mr. Sutherland:

Enclosed is an Incidental Harassment Authorization (IHA) issued to Scripps Institution of Oceanography, pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 et seq.), to take by harassment, marine mammals incidental to conducting an oceanographic seismic survey in the South Pacific Ocean by the *R/V Roger Revelle*. Scripps is required to comply with the conditions contained in the IHA. In addition, Scripps must cooperate with any Federal, state, or local agency monitoring the impacts of your activities, and submit a draft report to the National Marine Fisheries Service's (NOAA Fisheries) Office of Protected Resources, within 90 days after completion of the work authorized herein. Along with other mitigation measures to be incorporated, the IHA requires monitoring for the presence and behavior of marine mammals.

Please note that this IHA is not valid until our office receives the signed copy of the signature page. You may submit the copy by facsimile to 301-427-2521 and confirm by mail or e-mail. If you have any questions concerning the IHA or its requirements, please contact Ken Hollingshead, NOAA Fisheries, Office of Protected Resources, at (301) 713-2289, ext. 128.

Sincerely,

Donna Wieting
(for)
James H. Lecky
Director
Office of Protected Resources

Enclosure

Printed on Recycled Paper

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL MARINE FISHERIES SERVICE

Incidental Harassment Authorization

The Scripps Institution of Oceanography, La Jolla, California, is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1371 (a)(5)(D)) and 50 CFR 216.107, to take, by Level B Harassment, small numbers of marine mammals incidental to conducting a marine seismic survey program in the South Pacific Ocean, contingent upon the following conditions:

1. This Authorization is valid from December 12, 2006, through December 11, 2007.

2. This Authorization is valid only for activities associated with the *R/V Roger Revelle* conducting a seismic survey program in the South Pacific Ocean.

3. (a) The taking, by incidental harassment only, is limited to the species listed under condition 3(b) below. The taking by serious injury or death of these species or the taking by harassment, injury or death of any other species of marine mammal is prohibited and may result in the modification, suspension or revocation of this Authorization.

(b) The species authorized for incidental harassment takings are:

(*i*) Mysticete whales: humpback whale (*Megaptera novaeangliae*), southern right whale (*Eubalaena australis*), pygmy right whale (*Caperea marginata*), minke whale (*Balaenoptera acutorostrata*), Antarctic minke whale (*B. bonaerensis*), sei whale (*B. borealis*), fin whale (*B. physalus*), Bryde's whale (*B. edeni*), and blue whale (*B. musculus*);

(*ii*) Odontocete whales/dolphins: sperm whale (*Physeter macrocephalus*), dwarf sperm whale (*Kogia sima*), pygmy sperm whale (*K. breviceps*), southern bottlenose whale (*Hyperoodon planifrons*), Arnoux's beaked whale (*Berardius arnuxii*), Cuvier's beaked whale (*Ziphius cavirostris*), Shepherd's beaked whale (*Tasmacetus shepherdi*), Andrew's beaked whale (*Mesoplodon bowdoini*), Blainville's beaked whale (*M. densirostris*), ginkgo-toothed whale (*M. ginkgodens*), Gray's beaked whale (*M.. grayi*), Hector's beaked whale (*M.. hectori*), strap-toothed whale (*M. layardii*), spade-toothed whale (*M. traversii*), rough-toothed dolphin (*Steno bredanensis*), bottlenose dolphin (*Tursiops truncatus*), pantropical spotted dolphin (*Stenella attenuata*), spinner dolphin (*S. longirostris*), striped dolphin (*S. coeruleoalba*), short-beaked common dolphin (*Delphinus delphis*), hourglass dolphin (*Lagenorhynchus cruciger*), Fraser's

dolphin (*Lagenodelphis hosei*), Risso's dolphin (*Grampus griseus*), southern right whale dolphin (*Lissodelphis peronii*), spectacled porpoise (*Phocoena dioptrica*), melon-headed whale (*Peponocephala electra*), pygmy killer whale (*Feresa attenuata*), false killer whale (*Pseudorca crassidens*), killer whale (*Orcinus orca*), long-finned pilot whale (*Globicephala melas*) and short-finned pilot whale (*G. macrorhynchus*);

(*iii*) Pinnipeds: southern elephant seal (*Mirounga leonina*), leopard seal (*Hydrurga leptonyx*), crabeater seal (*Lobodon carcinophagus*), Antarctic fur seal (*Arctocephalus gazella*), and sub-Antarctic fur seal (*A. tropicalis*).

(c) The authorization for taking by harassment is limited to the following acoustic sources without an amendment to this Authorization:

(*i*) A seismic airgun array with no more than 2-General Injector (GI) airguns operating;
(*ii*) A multi-beam bathymetric sonar; and
(*iii*) A sub-bottom profiler.

(d) The taking of any marine mammal in a manner prohibited under this Authorization must be reported within 48 hours of the taking to the Chief of the Permits, Conservation and Education Division, Office of Protected Resources, National Marine Fisheries Service, at (301) 713-2289, or his designee.

4. The holder of this Authorization is required to cooperate with the National Marine Fisheries Service and any other Federal, state or local agency monitoring the impacts of the activity on marine mammals. The holder must notify the Chief of the Permits, Conservation and Education Division, Office of Protected Resources at least 48 hours prior to starting the seismic survey (unless constrained by the date of issuance of this Authorization in which case notification shall be made as soon as possible).

5. Mitigation. Under the MMPA and the Reasonable and Prudent Measures contained in the Incidental Take Statement issued under Section 7 of the Endangered Species Act for this action, the holder of this Authorization is required to:

(a) (*i*) Establish and monitor the safety zone for cetaceans and sea turtles surrounding the 2-GI airgun array where the received level would be 180 dB re 1 µPa rms. This radius is estimated to be 40 m (131 ft) from the seismic source in water depth greater than 1000 m (3280 ft);

(*ii*) Establish and monitor the safety zone for pinnipeds surrounding the 2-GI airgun array where the received level would be 190 dB re 1 µPa rms. This radius is estimated to be 10

m (33 ft) from the seismic source in water depths greater than 1000 m (3280 ft);

(b) To the extent practicable, whenever a marine mammal is detected outside the safety radius, and based on its position and motion relative to the ship track is likely to enter the safety radius, an alternative ship speed or track will be calculated and implemented. to further avoid injury to the animal.

(c) If taking an alternative ship speed or track is not effective and the marine mammal is still likely to enter the safety zone, then immediately shut-down the seismic airgun array and/or other acoustic sources, whenever any marine mammals and sea turtles are sighted approaching close to or within the area delineated by the 180 dB (re 1 μPa_{rms}), or 190 dB (re 1 μPa_{rms}) isopleth as established under condition 5(a) for the 2-GI airgun array.

(d) A power-down of the airguns is not authorized; both airguns must be shut-down whenever a marine mammal enters its designated safety zone.

(e) Not proceed with ramping up airguns from a shut-down unless the entire safety zones described in condition 5(a) are visible and no marine mammals and sea turtles are detected within the appropriate safety zones; or until 15 minutes (for small odontocetes, pinnipeds or sea turtles) or a minimum of 30 minutes (for mysticetes/large odontocetes) after there has been no further visual detection of the animal(s) within the safety zone and the trained marine mammal observer on duty is confident that no marine mammals and sea turtles remain within the appropriate safety zone. During ramp-up procedures, the safety radius for the 2 GI-guns will be maintained.

(f) Prior to commencing ramp-up described in condition 5 (h), conduct a 30-minute period of observation by at least one trained marine mammal observer (i) at the commencement of seismic operations and (ii) at any time electrical power to the airgun array is discontinued for a period of 4 minutes or more.

(g) If the complete safety radii are not visible for at least 30 minutes prior to ramp-up in either daylight or nighttime, not commence ramp-up.

(h) If no marine mammals and sea turtles have been observed while undertaking mitigation condition 5(c) and 5(f), ramp-up airgun arrays no greater than 1 GI-gun per 5-minute interval or approximately 6 dB per 5-minute period: (i) At the commencement of seismic operations, and (ii), anytime after the airgun array has been shut down for more than 4 minutes.

(i) Whenever possible, reduce the volume of the airgun array during vessel transits and turns while running seismic lines.

(j) Emergency shut-down. If observations are made or credible reports are received that one or more marine mammals or sea turtles are within the general operating area of this

activity in an injured or mortal state, or are indicating acute distress, the seismic airguns will be immediately shut down and the Chief of the Permits, Conservation and Education Division, Office of Protected Resources or a staff member contacted. The airgun array will not be restarted until review and approval has been given by the Director, Office of Protected Resources or his designee.

6. Monitoring.

(a) The holder of this Authorization must designate at least two biologically-trained, individuals to be onboard the *R/V Roger Revelle*, approved in advance by National Marine Fisheries Service, to conduct the visual monitoring programs required under this Authorization and to record the effects of seismic surveys and the resulting noise on marine mammals and sea turtles.

(b) Monitoring is to be conducted by the biological observers described in condition 6(a) above, onboard the active seismic vessel. At least one observer must be on active watch whenever any of the following occurs: (i) the seismic airgun array is operating during daytime airgun operations; (ii) during any nighttime start-ups of the airguns; and (iii) at night, whenever daytime monitoring resulted in one or more shut-down situations due to marine mammal presence. To the maximum extent possible two observers will be on-watch whenever the seismic array is being ramped up to (*1*) ensure that no marine mammals or sea turtles enter the appropriate safety zone whenever the seismic array is on, and (*2*) to record marine mammal and sea turtle activity as described in condition 6(f) below.

(c) To the extent possible, observers will be on watch for continuous periods up to 4 hours.

(d) At all times, the crew must be instructed to keep watch for marine mammals and sea turtles. If any are sighted, the bridge watch-stander must immediately notify the biological observer on-watch. If a marine mammal or sea turtle is within, or closely approaching, its designated safety zone, the 2-GI airgun array must be shut-down immediately.

(e) Observations by the biological observers described in condition 6(a) on marine mammal presence and activity will begin a minimum of 30 minutes prior to turning on and ramping up the seismic source.

(f) Monitoring will consist of noting: (*i*) the species, group size, age/size/sex categories (if determinable), the general behavioral activity, heading (if consistent), bearing and distance from seismic vessel, sighting cue, behavioral pace, and apparent reaction of all marine mammals and sea turtles seen near the seismic vessel and/or its airgun array (e.g., none, avoidance, approach, paralleling, etc.) and; (*ii*) the time, location, heading, speed, and activity of the vessel (shooting or not), along with sea state, visibility, cloud cover and sun glare at (1) any

time a marine mammal or sea turtle is sighted, (2) at the start and end of each watch, and (3) during a watch (whenever there is a change in one or more variable); and, (iii) the identification of all vessels that are visible within 5 km of the seismic vessel whenever a marine mammal is sighted, and the time observed, bearing, distance, heading, speed and activity of the other vessel(s).

(g) Biological observers will also conduct monitoring onboard the *R/V Roger Revelle* while the seismic array is being deployed or being pulled from the water.

(h) All biological observers must be provided with and use appropriate night-vision devices, Big Eyes, and reticulated and/or laser range finding binoculars.

(i) All biological observers must watch for marine mammals and sea turtles from the highest practical vantage point on the vessel, which is either the bridge or the flying bridge.

7. Reporting.

(a) A draft report must be submitted to the National Marine Fisheries Service within 90 days after the end of the seismic survey program in South Pacific Ocean. The report will describe in detail (*i*) the operations that were conducted, (*ii*) the marine mammals that were detected near the operations, (*iii*) to the extent possible the results of the acoustical measurements to verify the safety radii, and (*iv*) the methods, results, and interpretation pertaining to all monitoring tasks, a summary of the dates and locations of seismic operations, sound measurement data, marine mammal sightings (dates, times, locations, activities, associated seismic survey activities), and estimates of the numbers of affected marine mammals and a description of their reactions.

(b) The 90-day draft report will be subject to review and comment by the National Marine Fisheries Service. Any recommendations made by the National Marine Fisheries Service must be addressed in the final report prior to acceptance by the National Marine Fisheries Service. The draft report will be considered the final report for this activity under this Authorization if the National Marine Fisheries Service has not provided comments and recommendations within 90 days of receipt of the draft report.

8. Activities related to the monitoring described in this Authorization do not require a separate scientific research permit issued under section 104 of the Marine Mammal Protection Act.

9. A copy of this Authorization must be in the possession of the holder of the Authorization and operator of the vessel operating under the authority of this Incidental

Harassment Authorization.

10. The permit holder, in signing this IHA, has accepted and will comply with the provisions of this IHA.

11. Penalties and Permit Sanctions: Any person who violates any provision of this IHA is subject to civil and criminal penalties, permit sanctions, and forfeiture as authorized under the Marine Mammal Protection Act.

Donna Wieting (for)

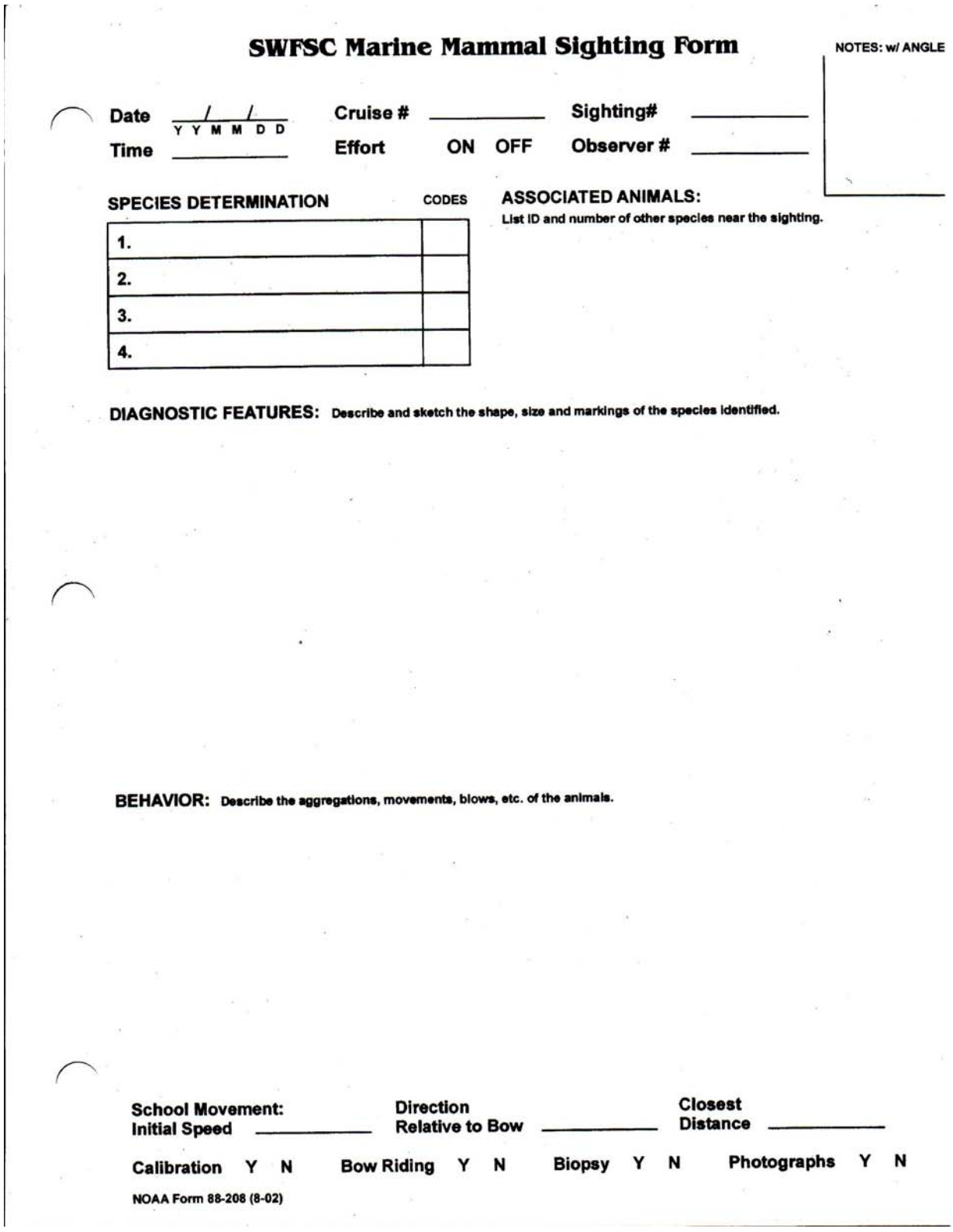
James H. Lecky
Director, Office of Protected Resources
National Marine Fisheries Service

DEC 12 2006
Date

Mr. Woody C. Sutherland
University of California, San Diego
Scripps Institution of Oceanography
La Jolla, California

Date

B. NOAA Sighting Form



SWFSC Marine Mammal Sighting Form

NOTES: w/ ANGLE

Date ___/___/___ (Y Y M M D D) Cruise # _____ Sighting# _____

Time _____ Effort ON OFF Observer # _____

SPECIES DETERMINATION CODES

1.	
2.	
3.	
4.	

ASSOCIATED ANIMALS:
List ID and number of other species near the sighting.

DIAGNOSTIC FEATURES: Describe and sketch the shape, size and markings of the species identified.

BEHAVIOR: Describe the aggregations, movements, blows, etc. of the animals.

School Movement: Initial Speed _____ Direction Relative to Bow _____ Closest Distance _____

Calibration Y N Bow Riding Y N Biopsy Y N Photographs Y N

NOAA Form 88-208 (8-02)

Behavioral Observations

When first observed, do you think the animals were already reacting to the research vessel? Y N U O

I. School Behavior

What was the behavior of the school when first observed (circle all that apply):

fast traveling | moderate traveling | slow traveling | milling | associated swimming | approaching | bow riding | unknown | other

Did the behavior change one or more times during observation? Y N U O

If yes, what did the behavior change to (circle all that apply)?

fast traveling | moderate traveling | slow traveling | milling | associated swimming | approaching | bow riding | unknown | other

II. School Shape

What was the school shape when first observed? tight & uniform | tight & clumped | loose & uniform | loose & clumped | unknown | other

Did the school shape change one or more times during observation? Y N U O

If yes, what did the school shape change to? tight & uniform | tight & clumped | loose & uniform | loose & clumped | unknown | other

III. School Composition

Calves present? Y N U O

If yes, estimate percent_____: were neonates present? Y N U O

IV. Reaction to the Vessel

					Distance reticle OR estimate	
Approach the boat?	Y	N	U	O	_____	_____
Bow ride?	Y	N	U	O		
Run from the boat?	Y	N	U	O	_____	_____
Low swimming?	Y	N	U	O	_____	_____
Did the school split?	Y	N	U	O	_____	_____
If yes, did the subgroups move off in different directions?	Y	N	U	O		

If it's a mixed school, was the last observed subgroup composition: mixed | single species | both mixed & single species | unknown | other

V. In your estimation, relative to the research vessel, was this school:

evasive | non-evasive (including attracted to the boat and/or indifferent) | both | cannot be determined | other

If the school was evasive, at what distance did you first see a strong evasive response (ie., when did the dolphins get up and run)? _____ _____

Key: Y = yes N = no U = unknown/cannot be determined O = other, please explain

Guide to Behavioral Data Collection (for Observers) – CSCAPE 2005
Protocol and some hints for recording behavioral data on Marine Mammal Sighting Forms
24 May 2005

GENERAL INSTRUCTIONS

Purpose: The purpose of recording behavioral observations on the sighting forms is to enable us to standardize the behavioral data that comes back from the field. We will use these data to document the reaction of dolphins to the research vessel and to better understand how dolphin behavior affects our ability to detect and count animals. We greatly appreciate your time and effort in this pursuit. You are our eyes; tell us what you see!

Use: The behavior fields on the front and the back of the Marine Mammal Sighting Form should be filled out for each sighting. We would like your observations on every species but we also know that you are under tight time constraints on the flying bridge. Therefore, sampling priorities are:

Priority Group 1.	small delphinids (common, white-sided, striped, bottlenose) and porpoises
Priority Group 2.	pilot whales, Risso's; all other medium-sized delphinids;
Priority Group 3.	any other odontocete species.

We have collected behavioral data on these species during the previous ORCAWLE cruise and similar data are also collected during the CalCOFI cruises, enabling us to better understand the vessel response behavior of California current animals. In addition, these data provide interesting comparisons to data collected on the same species in the eastern Tropical Pacific.

Questions: During CSCAPE 2005 we have two main questions, which build upon what we have learned by observing dolphin behavior in previous cruises:

(1) *Ship avoidance/attraction*. To look at the behavior of cetaceans relative to our presence, we are collecting data on the movement of dolphin schools relative to the research vessel.

(2) *Sex and age composition of schools*. Little is known about the social structure of pelagic dolphins. We will use these sighting forms to gain insights into how the sex and age composition of schools influences observable school behavior.

Forms: The following forms are designed to be used together. The *SWFSC Marine Mammal Sighting Form* (NOAA Form 88-208) has a front and a back side on which to record your behavioral observations. The *"Observer Guide to Dolphin Behavior"* defines terms and standardizes terminology. Please refer to it when describing dolphin behavior. It is pasted into the front of your green book. The *"Guide to Behavioral Data Collection for Observers"* (this document) describes the protocol for recording behavioral observations on the flying bridge and instructions for filling out the sighting form.

Data entry: Eric Archer created an Access data entry program for transcribing the behavioral data on the sighting forms into the Behavior Data Archive. Ideally, one observer would be designated to do this throughout the cruise and would enter the behavioral data each evening.

Protocol: You've just sighted a dolphin school at 30 degrees right, reticle 1.3. What do you do?

The first priority for you and the rest of the observers is to make your species identification and abundance estimates. Then, make your behavioral observations. We are especially interested in whether the dolphins react to the research vessel and at what distance they react. If you, or any other observer, see such a change in dolphin behavior, call out the reticle to the recorder who will record a resighting in WINCRUZ. It is very important that the recorder also records a comment so that we know that this resighting referred to a change in dolphin behavior. In the comment field, write something concise like: "dolphins run from research vessel". If the dolphins changed behavior while you were in the middle of making your abundance estimate, don't interrupt what you're doing, but note the reticle if possible (or just estimate the distance by eye) and keep it in mind until you have a moment to tell the recorder or to write it on the sighting sheet.

After making your species ID and abundance estimate, it is best to fill out the front and the back of the sighting form while you are still on watch. We've designed the back of the form to go as fast as possible; just circle the appropriate answer. If you do not have time, make a few notes and fill out the behavioral fields after the watch.

In general, observers fill out the narrative portion after their watch is over. You might also want to write more later on when you have a chance to chat with the other observers. This is fine; in fact we encourage you, to talk with the other observers about dolphin behavior. Add their observations to the narrative (or ask them to add a sheet of their own).

Some general notes on recording behavioral data*:* Behavioral data is inherently variable and difficult to quantify reliably. However, if the terminology and the data collection are standardized, we can gain considerable information from the field that would otherwise be lost. Here are a few other hints when recording behavioral data:

Categorical data. We've tried to strike a balance between making the form quick and easy to fill out (by creating behavioral categories for you to circle) and by leaving room for you to describe your observations (in the narrative). On the backside of the sighting form, do your best to pick one of the categories. Undoubtedly, situations will arise in which our categories do not describe what you see. There are options to cover these situations:

> U = unknown/cannot be determined; use this when you did not systematically look for a particular behavior. For example, if the question is, "Calves present?" but the school was at reticle 0.1 and you feel that you

would not have been able to see calves at that distance, even if they had been present, then you should circle the "U."

O = other/please explain; use this category when you do not think that what you observed is explained by the categories given. If this is the case, circle the "O" and use the narrative to describe what you did observe.

Leaving fields blank. Please don't. Let's say the question on the sighting form is: "bow-riding?" and you leave the field blank. Back on dry land, we do not know if you looked for bow-riding and didn't see it (a negative answer) or if you didn't or couldn't look (an unknown/cannot be determined answer).

Describe what you see. The most important trick to good behavioral observations is to describe only what you see. Please keep what you see (your description of dolphin behavior) separate from what you think is going on (your interpretation of dolphin behavior). It is important to communicate both to us, however. You are the best one to interpret what is going on out there because you can take the entire scene into account. For example, please don't just write dolphins are "feeding." How do you know they are feeding? Write instead … "I observed three dolphins with tightly rounded backs, diving slowing and surfacing with fish in their mouths," or, "I *think* they were feeding." Similarly, if you think that the dolphin school was *"evasive*" (your interpretation), please describe the specific dolphin behaviors that gave you that impression (e.g., the dolphins "ran," "scattered," and "frequently changed direction," etc.).

Change in behavior. Because we are interested in dolphin behavior in response to the research vessel, we are talking about *changes* in dolphin behavior. There are two tricks to recording changes in behavior. First, have a firm idea of what *no change*, or in this case what *no response* to the research vessel, would look like. (*No response* = dolphins just keep on doing exactly the same thing, before, during and after the research vessel moved on through.) The second trick to describing changes in behavior is to record what was happening *initially* (e.g., before the dolphins detected the research vessel) and what happened *subsequently* (after they detected the research vessel). You should be able to say something like this … "When *initially* sighted, the dolphins were milling around in a loosely spaced school. *Then*, the dolphins closed ranks, and they began to run directly away from the ship." We need your description of events before and after the dolphins detect the ship to determine if a change in behavior occurred.

THE FRONT OF THE SIGHTING FORM

Narrative

Please use the narrative section on the front of the sighting form to describe dolphin behavior in detail. Use additional paper if needed and feel free to draw us a map of the dolphin track during the sighting. We are especially interested in you elaborating on the following:

Describe dolphin behavior. What were the dolphins doing? We use the terms milling, traveling and associated-swimming but elaborate, tell us about their aerial activity, diving behavior, etc.

What are dolphins doing when they associate with birds and tuna? We don't know what the dolphins are doing when they aggregate with birds and tuna. Describe what the dolphins are doing. How is it different than what dolphins do when they are not in these multi-species aggregations? Please systematically look for evidence of dolphin feeding.

How did the school respond to the research vessel? For example, if you circled on the back side of the sighting form that the school was *"evasive,"* in the narrative please describe the specific dolphin behaviors that gave you that impression (*evasive* = the dolphins "ran," "scattered," and "frequently changed direction," etc.). If your impression was that the school was *not evasive*, please tell us the behaviors that you observed that gave you that impression (*not evasive* = the dolphins showed "no response" to the research vessel or they were "attracted" to the research vessel; e.g., bow-riding or wake-riding). See note above on recording changes in behavior.

If dolphin behavior changed in response to the research vessel, when did it change? Describe behavior before and after and record the reticle/distance at which the change was detected. Remember to record the angle and reticle at which dolphin behavior changed and to record a resight in WINCRUZ.

Describe the composition and spatial distribution of the school. Please describe the species composition of the school. Describe age (calves, juveniles, adults present?) and gender (can you see any adult males?) of the dolphins. Describe the spatial distribution of individuals within the school; is it uniform or are different types of dolphins seen together?

Does the school change shape in response to the research vessel? If the school splits, please describe the sequence of events and what happens to the different species in mixed-species schools.

****Note: Mixed species sightings**

If the sighting contains multiple species, please take care when filling out the back of the sighting form to indicate which species performed which behavior. If only one response is circled for each question, we can only assume that each species performed the exact same behaviors throughout the sighting, which is rarely the case! One method would be to put a circle around the behavior for one species, and a square around the behavior for the second species, and draw a key indicating which symbol represents which species.

In your estimation, were the animals already reacting to the research vessel?

Sometimes, when you *first* make a sighting, the school is already moving away from the research vessel, or toward it. We need to know if, in your estimation, you observed the dolphins before they responded to the research vessel (a negative answer) or if you think that the dolphins were already responding to the research vessel when first sighted (a positive answer).

School Behavior

Behavior when first observed: Choices are traveling, milling, associated-swimming, approaching the ship, and bow-riding. We've tried to make the categories as mutually exclusive as possible, but sometimes they will not work out that way. Circle all that apply and use the narrative to explain. For example, you might observe dolphins "associated swimming" that are also "slow traveling" … circle both.

Did dolphin behavior change during the observation? Y or N**.** What we are asking here is whether or not you think that dolphin behavior changed during the course of the sighting. If the answer is a positive one, remember to record a resight, so that we can determine the distance at which the change occurred. When you first observed the school, if they were traveling rapidly away from the ship and they continued to do this until you lost them in the distance, record a negative answer (no, dolphin behavior did not *change* during the sighting). Note: dolphin behavior might have changed before the sighting, but you did not see that. If you record a negative answer, do not answer the next question.

If behavior changed, what did the behavior change to? Answer this only if you answered "yes" to the previous question. Choices are the same as above; circle all that apply.

School Shape

As above, we are interested in the initial shape of the school and whether or not it changed during the sighting. If it did change, what did it change to? Please see terms regarding aggregation (tight or loose) and clumping (uniform or clumped).

School Composition

Were calves present? Y or N. We don't really know how to tell what a "calf" is either! What we mean by a calf is one that is dependent on its mother and thus still nursing. We cannot, however, tell whether an individual is nursing just by looking. Do your best; look for small animals with different coloration patterns than adults and – most importantly – look to see whether the animal is in the "calf position," that is, swimming in close proximity to an adult (presumably the mother, but we don't have anyway of knowing this either). Do your best to estimate the percentage or to quantify the number of calves present. What if you see "juveniles?" Juveniles are not calves. We define juveniles as individuals that are no longer nursing, not swimming in "calf position," but that have yet to reach adult size (and along with it sexual or social maturity). Answer "no" to the question about calves but please do tell us about the presence of juveniles in the narrative.

If you answered "yes" to the previous question, please estimate the percent of calves in the school. Were neonates present? Neonates we define as calves that are visibly pink and/or with fetal folds and/or with folded dorsal. Again, do your best to quantify the percentage or number of neonates that you observe.

Reaction to the Vessel

Please see the definition of terms. The questions we ask here are only some of the many possible reactions dolphins might have to the research vessel. Please use the narrative to describe other types of reactions not mentioned here. We are interested in both the presence/absence of these behaviors and the distance at which they occur from the ship. Estimate distance either by recording the reticle or by eye.

Does the school split? Y or N. After detecting the ship, the school may split into smaller groups. These subgroups can vary in size from one individual to many. Not applicable to schools that when initially sighted are already in subgroups (a "clumped" distribution). "Shattering" or "exploding" or "starburst" describes a special case when dolphins move away in all different directions, singly or in groups.

If the school splits, do the subgroups move off in different directions? Y or N. What we are trying to get at here is whether the subgroups continue to move in the same direction (e.g., the school breaks up into subgroups but all subgroups continue moving north) or if they move away from one another (e.g., the school splits up and the subgroups scatter in different directions).

If the school splits, and it's a mixed species school, is the subgroup composition: mixed or single species? Answer this question only if the school was a mixed school. Answer this question when you last see the school; consider the species composition at the end of the splitting. We are curious about how the two species segregate themselves when a school splits up. Do the subgroups have the same composition as the initial school? Our impression (from observer observations) is that generally, when a mixed school splits up, the two species segregate into single species subgroups. This question may be slightly confusing to answer as we understand that in mixed schools (before they are disturbed), the species are often segregated spatially (e.g., a small group of spinners in the back of a big school of spotters). For the sake of answering this question, however, consider this a mixed species school and don't worry about where the species are located in the school. Now, let's imagine that the ship approaches this school and then it splits up. Wait till the end of the sighting and take a look at the subgroups …. are they single or mixed species?

Please use the narrative to fill in the details.

In your estimation, relative to the research vessel, was this school …

Here, we are interested in your opinion of the schools reaction to the research vessel. Choices are *evasive* (e.g., running, low swimming, frequent changes of direction, school splitting, etc.); *non-evasive* (e.g., schools that show no response to the research vessel or that show a positive response to the research vessel such as attracted to the boat, bow-riding, or wake-riding, etc.); or *both* (e.g., most individuals within the school run but some individuals come over and bow-ride).

If you answered "evasive" to the previous question, please estimate the distance (reticle or by eye) from the ship at which you felt the animals showed a strong evasive response (i.e., when the dolphins got up and ran).

We thank you for your time in filling out these forms.

Questions/comments: Sarah Mesnick (sarah.mesnick@noaa.gov) or Anne Allen (anne.allen@noaa.gov).

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Observer guide to dolphin behavior

I. School Behavior

A. *Traveling* – the movement in a given direction of an individual or school, at approximately 3 knots or greater. Movement of school is polarized (all individuals are moving in the same direction) and coordinated (moving at the same pace). Aerial activity may be observed. Can be:

1. *Fast traveling* – characterized by rapid, directed swimming with many porpoising individuals; school is highly polarized.
2. *Moderate traveling* – some of the individuals are porpoising; school is traveling at medium speeds.
3. *Slow traveling* – few or no individuals porpoising; school is traveling at slower speeds; movement of the school is less directed and school may be less polarized.

B. *Milling* – animals remain in the same general area; school is not polarized. Movement of individuals is characterized by frequent changes in direction over a small spatial scale; speed approximately less than 2 knots. Aerial activity may be observed.

2. Associations

A. *Associated-swimming* – swimming/diving in association with birds and tuna. Generally, individuals are moving slowly, diving and spendingless time at the surface. The school is not polarized. It is not known if the dolphins are feeding at this time, even if there is evidence that the birds and tuna are feeding, so this term should be used only with direct evidence of feeding dolphins. *Note: animals can be associated-swimming while traveling or milling.

III. Individual Behavior

A. *Lob tailing* – one or more individuals slapping the surface of the water with the tail flukes. This behavior makes splashes on the water.

B. *Aerial activity* – one or more individuals are seen leaping, spinning, breaching, tail walking, roto-tailing, head slapping, etc. These activities usually associated with splash entries into the water.

C. *Porpoising* – smooth arching leaps clear out of the water while traveling; entry into the water is splashless and rostrum first.

D. *Other* – describe behavior.

IV. Behavior Relative to the Research Vessel

* Please note the distance from the ship at which the behavior first occurs (reticle or estimate by eye)

A. *Approach the boat* – individual/s alter course to swim directly towards the vessel, approaching but not bow riding.

B. *Bow riding* – diving and surfacing in the bow wave of the boat.

C. *Wake riding* – diving and surfacing in the wake of the boat.

D. *Running from the boat* – swimming at high speed directly away from the boat. This means that the school has changed direction and/or increased speed.

E. *School splitting* – a larger school breaks up into smaller groups, which are spatially segregated clusters of animals. Subgroups may vary in size but they are always smaller than the initial school. Please describe how the school splits up and the species

composition of the school before and after splitting. "Shattering" describes a special case when dolphins move away in all directions, singly or in small groups.

1. When the school first splits, do the individuals/subgroups:
   a. *move off in different directions.*
   b. *continue to move in the same direction.*

2. During your final observation of the school, is the composition:
   a. *mixed* – different species in the same subgroup.
   b. *single species* – subgroups are species-specific.

F. *School coalescing* – after initial sighting, a more scattered school closes ranks and becomes more tightly aggregated, cohesive, and polarized.

G. *Low swimming* – only the dorsals or small patches of back are visible at the surface, making the animals very difficult to see.

H. *Other "evasive," "attractive," or "neutral" behaviors* – describe any other behaviors that you think may indicate that the dolphins are attracted to, are avoiding, or are not responding to the research vessel.

V. Spatial Distribution of Individuals

A. *Aggregation* – the distance between individuals within the school.

1. *tight* - most animals are within one body length of each other. School has easily discernible shape; the beginning and end are well defined.
2. *loose* - most animals are distributed greater than one body length apart. School shape is difficult to discern; the beginning and end are not well defined.

B. Clumping – the degree of clustering within the school.

1. *uniform* – ca. equal amounts of space between all individuals in the school.
2. *clumped* – the school is divided into subgroups, with more space between subgroups than among individuals in each subgroup.

VI. Composition of Schools

A. Note the presence or absence of neonates, calves and/or juveniles in the school.

B. Note the species composition of the school at the beginning and end of the sighting.